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[Title of the Invention] LIQUID CRYSTAL DISPLAY PANEL MANUFACTURING METHOD AND MANUFACTURING DEVICE

[Abstract]

[Object] There is provided a liquid crystal display panel manufacturing method capable of performing a process of binding a pair of substrates of a liquid crystal display panel with a sheet type preliminary curing, directed to a liquid crystal display panel manufacturing method and manufacturing device that bonds and encapsulate the pair of glass substrates using a thermosetting resin.

[Solving Means] A process comprising: (a) overlapping a pair of glass substrates using a thermosetting resin through a sealing material and spacers, to arrange the overlapping substrate; (b) interposing the overlapping substrate between a pair of heating plates, successively heating and pressing the substrate, and preliminarily curing the sealing material; and (c) heating the overlapping substrate having the sealing material preliminarily cured to thus complete the curing of the sealing material.

[Claims]

[Claim 1] A liquid crystal display panel manufacturing method comprising:

(a) overlapping a pair of glass substrates using a

thermosetting resin through a sealing material and spacers, to arrange the overlapping substrate;

(b) interposing the overlapping substrate between a pair of heating plates, successively heating and pressing the substrate, and preliminarily curing the sealing material; and

(c) heating the overlapping substrate having the sealing material preliminarily cured to thus complete the curing of the sealing material.

[Claim 2] The liquid crystal display panel manufacturing method according to Claim 1, wherein the thermosetting resin is selected from a group consisting of an epoxy resin, an acrylic resin, and a phenol novolac resin.

[Claim 3] The liquid crystal display panel manufacturing method according to Claim 1 or 2, wherein a heating temperature of the process (b) is in a range of 80℃ to 230℃.

[Claim 4] The liquid crystal display panel manufacturing method according to any one of Claims 1 to 3, wherein an applied pressure of the process (b) is in a range of 0.1 kg/cm^2 to 3 kg/cm^2.

[Claim 5] The liquid crystal display panel manufacturing method according to any one of Claims 1 to 4, wherein the process (B) continues for more than two minutes.

[Claim 6] The liquid crystal display panel manufacturing method according to any one of Claims 1 to 5, further

comprising:

(d) between the processes (b) and (c) carrying the overlapping substrate having the sealing material preliminarily cured

[Claim 7] The liquid crystal display panel manufacturing method according to Claim 6,

wherein in the process (a), a plurality of overlapping substrates are formed;

wherein in the process (b), the overlapping substrates are processed in a sheet type one by one; and

wherein in the process (c), the overlapping substrates having the sealing material preliminarily cured are processed in a plural batch type.

[Claim 8] The liquid crystal display panel manufacturing method according to Claim 7,

wherein the process (b) is performed in parallel using a plurality of hot presses; and

wherein in the process (d), the plurality of overlapping substrates processed in the plurality of hot presses are received in one cassette, and carried in one heating furnace.

[Claim 9] The liquid crystal display panel manufacturing method according to Claim 8, wherein a heating time of the process (c) is 5 times loner than the heating and pressing time of the process (b).

[Claim 10] The liquid crystal display panel manufacturing method according to Claim 8, wherein a heating time of the process (c) is 10 times loner than the heating and pressing time of the process (b).

[Claim 11] A liquid crystal display panel manufacturing device, comprising:

a plurality of hot presses adapted to respectively heat and press a stacked substrate having a pair of glass substrates through a sealing material and spacers using a thermosetting resin, and preliminarily cure the thermosetting resin;

a carrying apparatus adapted to carry in/out a plurality overlapping substrates one after another, using the plurality of hot presses; and

a controller adapted to control carrying in the plurality of overlapping substrates on after another using the plurality of hot presses, performing a preliminary curing on the thermosetting resin heated and pressed in parallel in the plurality of hot presses, and carrying out the plurality of overlapping substrates preliminarily cured by the thermosetting resin one after another.

[Claim 12] The liquid crystal display panel manufacturing device according to Claim 11, further comprising:

a curing furnace for simultaneously receiving the

plurality of overlapping substrates having a thermosetting resin preliminarily cured, and heating the plurality of overlapping substrates to primarily cure the thermosetting resin.

[Claim 13] The liquid crystal display panel manufacturing device according to Claim 12, wherein the carrying apparatus comprises:

an apparatus for receiving the overlapping substrates carried out from the plurality of hot presses into a plurality of cassettes, and carrying in the cassettes to the curing furnace.

[Claim 14] The liquid crystal display panel manufacturing device according to any one of Claims 11 to 13, wherein the plurality of hot presses are connected in a cluster through the carrying apparatus.

[Claim 15] The liquid crystal display panel manufacturing device according to any one of Claims 11 to 13, wherein the plurality of hot presses are connected in series or parallel through the carrying apparatus.

[Claim 16] The liquid crystal display panel manufacturing device according to any one of Claims 11 to 15, further comprising:

a thermal chamber for receiving the plurality of hot presses.

[Claim 17] The liquid crystal display panel

manufacturing device according to any one of Claim 11 to 16, wherein the controller controls the plurality of hot presses in the same temperature, the same applied pressure, and the same processing time.

[Claim 18] The liquid crystal display panel manufacturing device according to any one of Claims 11 to 17, wherein the heating temperature is in a range of 80℃ to 230℃.

[Claim 19] The liquid crystal display panel manufacturing device according to Claim 17 or 18, wherein the applied pressure is in a range of 0.1 kg/cm^2 to 3 kg/cm^2.

[Claim 20] The liquid crystal display panel manufacturing method according to any one of Claims 17 to 19, wherein the processing time is more than two minutes.

[Detailed Description of the Invention]

[0001]

[Technical Field of the Invention]

The present invention relates to a liquid crystal display panel manufacturing method and manufacturing device and, more specifically, to a liquid crystal display panel manufacturing method and manufacturing device that bonds and encapsulate a pair of glass substrates using a thermosetting resin.

[0002]

[Description of the Related Art]

In a liquid crystal display panel, a liquid crystal layer having a thickness of several micrometers is interposed between two sheets of glass substrates. To encapsulate the liquid crystal layer, the liquid crystal layer is surrounded with a sealing material. The sealing material encapsulates the liquid crystal layer, and also serves as an adhesive to bond two sheets of glass substrates.

[0003]

When a pair of glass substrates are attached with the sealing material using the thermosetting resin, the thermosetting resin is cured in a heating and pressing furnace. A plurality of overlapping glass substrates are inserted into a heating plate, pressed, and thus the thermosetting resin is cured at one time. This batch type hot press device requires a large area, and becomes a large-sized and an expensive one.

[0004]

[Problems to be Solved by the Invention]

The present inventors intends to realize an device for curing an overlapping substrate in which a pair of glass substrates constituting a liquid crystal display panel overlap through a thermosetting resin, by heating and pressing the overlapping substrate, in a sheet type that processes the overlapping substrate one by one. In this

case, when the overall curing process is to be performed in a sheet type, it requires a processing time in a time unit. Therefore, when only one hot press is used, a throughput is significantly lowered.

[0005]

[Problems to be Solved by the Invention]

However, when a curing bridge reaction proceeds to a certain extent, a certain degree of coupling strength (bonding strength) is provided. Therefore, it has been contemplated that the curing bridge reaction is classified as a preliminary curing bridge reaction for performing a preliminary curing bridge, and a primary curing bridge reaction for fully performing a curing bridge reaction. Considering compatibility with the other manufacturing process, when the preliminary curing is to be performed in a sheet type, it has been understood that a plurality of hot presses are arranged in serial, and the preliminary curing is preferably divided into more than two steps.

[0006]

However, when the preliminary curing is performed, a position between a pair of substrates of the overlapping substrate is mismatched, or the overlapping substrate is bended, so that the subsequent process might not be corrected.

[0007]

An object of the present invention is to provide a liquid crystal display panel manufacturing method capable of performing a process of binging a pair of substrates of a liquid crystal display panel with a thermosetting resin, using a sheet type preliminary heating.

[0008]

Another object of the present invention is to provide a manufacturing device adapted to perform the above-mentioned manufacturing method.

[0009]

Still another object of the present invention is to provide a manufacturing method in which a restricted area can be effectively used and the liquid crystal display panel can be efficiently manufactured.

[0010]

[Means for Solving the Problems]

One aspect of the present invention provides a liquid crystal display panel manufacturing method comprising: (a) overlapping a pair of glass substrates using a thermosetting resin through a sealing material and spacers, to arrange the overlapping substrate; (b) interposing the overlapping substrate between a pair of heating plates, successively heating and pressing the substrate, and preliminarily curing the sealing material; and (c) heating the overlapping substrate having the sealing material preliminarily cured to

thus complete the curing of the sealing material.

[0011]

Another aspect of the present invention provides a liquid crystal display panel manufacturing device, comprising: a plurality of hot presses adapted to respectively heat and press a stacked substrate having a pair of glass substrates through a sealing material and spacers using a thermosetting resin, and preliminarily cure the thermosetting resin; a carrying apparatus adapted to carry in/out a plurality overlapping substrates one after another, using the plurality of hot presses; and a controller adapted to control carrying in the plurality of overlapping substrates on after another using the plurality of hot presses, performing a preliminary curing on the thermosetting resin heated and pressed in parallel in the plurality of hot presses, and carrying out the plurality of overlapping substrates preliminarily cured by the thermosetting resin one after another.

[0012]

[Embodiments]

Before describing the present invention, details of a preliminary experiment taken by the present inventors will be described. Figs. 7A to 7D are schematic cross sectional views for explaining a sheet type preliminary curing hot press process used by the present inventors.

[0013]

As shown in Fig. 7A, a carrying device 105 arranged to array hot presses 110 and 120 and include rollers carries overlapping substrates 131, 132, and 133. For the hot press 110 and 120, lower heating plates 114 and 124, and a pair of glass substrates are pressed and heated in which upper heating plates 112 and 122 overlap through a thermosetting resin.

[0014]

Fig. 7A shows a state where the overlapping substrate 131 is heated and pressed by the hot press 120, and the overlapping substrate 132 is heated and pressed by the hot press 110.

[0015]

Fig. 7B shows a state where, after a predetermined time, the upper heating plate 112 and 122 can be lifted and the carrying device 105 can carry the overlapping substrate. In this case, the overlapping substrate is moved one by one.

[0016]

Fig. 7C shows the overlapping substrate carried in one unit. The overlapping substrate 131 is carried outside the hot press after the process is complete, and the overlapping substrate 132 to which the hot press 12 performs a former hot press process is arranged to perform a latter process using the hot press 120 of the next stage. The overlapping

substrate 133 is newly carried in the hot press 110. In addition, the next overlapping substrate 134 waits.

[0017]

Fig. 7D shows a state where upper heating plates 112 and 122 are lowered and the overlapping substrates 133 and 132 are pressed and heated. The overlapping substrates 132 and 133 are interposed between the upper heating plates 122 and 112, and the lower heating plates 124 and 114, and pressed while heated by heat conduction.

[0018]

With the above arrangement, a pair of glass substrates which pass through two stages of preliminary curing process are bonded with a thermosetting resin in a sufficient strength.

[0019]

However, for the overlapping substrate preliminarily cured as described above, a position mismatch or a bending may be generated.

[0020]

The inventors investigated what causes the position mismatch or the bending.

[0021]

Fig. 7E is a graph showing a temperature change of the overlapping substrate preliminarily cured. The horizontal axis refers to an elapsed time t, and the vertical axis

refers to a temperature T. When heating and pressing process is performed using the first stage hot press, the temperature increases almost linearly to show a linear portion HP1. Further, when moving from the first stage hot press to the second stage hot press, the temperature is rapidly reduced for the moment, goes back to the original temperature, and incases almost linearly when the second stage hot press process starts.

[0022]

It was investigated which causes the substrate temperature to be rapidly reduced through the multistage hot press. After the substrate is processed through the first stage hot press, the upper heating plates 112 and 122 are lifted when they move to the second stage hot press. Then, an external air flows onto the overlapping substrate. The external air has a significantly low temperature relative to the heating temperature of the hot press.

[0023]

Therefore, the substrate temperature is rapidly reduced. However, since the substrate is arranged on the lower heating plate 114, the reduce temperature gap is not so large. When the substrate is carried from the first stage hot press 110 to the second stage hot press 120, the substrate is arranged on the lower heating plate 132 again. In an intermediary carrying state, the upper and lower

surfaces of the substrate are exposed to an ambient, and this causes the temperature to be rapidly reduced.

[0024]

When the second hot press process starts such that the substrate is carried in the second hot press, arranged on the lower heating plate 124, and the upper heating plate 122 is lowered, then, the temperature is increased again.

[0025]

A curing bridge reaction proceeds faster as the temperature increases. Therefore, when the multistage hot press process is performed, it is common to set the latter stage hot press to be a higher temperature. For example, the heating temperature of the first stage hot press 110 is set to 100℃~150℃, and the heating temperature of the second stage hot press 120 is set to 150℃~200℃.

[0026]

However, when moving from the first stage hot press to the second stage hot press, the curing bridge reaction of the thermosetting resin does not sufficiently proceed yet. In this state, the substrate is rapidly cooled and thus a heat distortion is generated. In addition, when the substrate is carried through a carrying apparatus such as a roller, a mechanical stress also reacts thereon. With this stress, a pair of substrates not yet bonded in a sufficient strength might be mismatched, or the overlapping substrate

might be bended.

[0027]

Preferred embodiments of the present invention will now be described with reference to the attached drawings. Figs. 1A to 1F show a process of bonding of a pair of glass substrates in an overlapping manner.

[0028]

As shown in Fig. 1A, an upper substrate US and a lower substrate LS are prepared. An alignment processing is performed such that a required electrode or an active element (color filter, if needed) is formed on each substrate, and an alignment layer is coated.

[0029]

As shown in Fig. 1B, a seal 11 is formed on the upper substrate US. As shown in Fig. 2A, the seal 11 includes an outer sealing material 11a, an inner sealing material 11c, and a fiber spacer 11b and a conductive spacer 11d interposed between therebetween.

[0030]

The conductive spacer 11d is used to electrically conduct between the upper substrate US and the lower substrate LS, which is spotted on required elements. The fiber spacer 11b is a spacer used to maintain the upper substrate US and the lower substrate LS to be in a predetermined gap while performing the overlapping process.

[0031]

The seal 11 is formed along the peripheral of the upper substrate US, and an injecting port 13 is formed with a certain gap left.

[0032]

As shown in Fig. 1C, the spacer 12 is scattered on the lower substrate LS. The spacer 12 is a spacer used to maintain a gap between the upper substrate US and the lower substrate LS in the display region to be an established value.

[0033]

As shown in Fig. 1D, the upper substrate US is turned over, moved on the lower substrate LS to match a position, and thus overlap. Through this process, the overlapping substrate is prepared.

[0034]

Fig. 2B is a cross sectional view schematically showing an arrangement of the overlapping substrate. The upper substrate US and the lower substrate LS are arranged to face each other with a certain gap. In a center portion of the display region of Fig. 2B, the spacer 12 demarcates a distance between both substrates. In the peripheral portion of the substrate, a gap between the pair of the substrate is demarcated using the seal 11 that interposes the fiber spacer with the sealing material.

[0035]

As shown in Fig. 1E, the overlapping substrate is carried in the hot press, inserted into the lower heating plate LHP and the upper heating plate UHP, and pressed and heated. In addition, in order to prevent a damage of a glass substrate, a buffer BF is arranged on at least one of the upper heating plate UHP and the lower heating plate LHP.

[0036]

The overlapping substrate is heated and pressed in the hot press device, and the hot press continues until a sufficient preliminary strength is obtained. Preferably, a preliminary curing operation is performed until a curing ratio of 40 to 95% reaches. When the curing ratio is less than 35%, the preliminary strength might be not enough. In order to accomplish the curing ratio of more than 96%, the hot press device is complicated, and a time needed in the hot press becomes longer, and thus a throughput is degraded.

[0037]

As shown in Fig. 1F, after the sufficient preliminary strength reaches, the overlapping substrate is carried in a curing furnace, pressed, and the seal 11 formed with the thermosetting resin is fully cured

[0038]

In the preliminary curing process through the hot press, a heating temperature slightly varies according to a used

thermosetting resin. When an epoxy resin is used as the thermosetting resin, the heating temperature is in a range of 80℃~180℃. When an acrylic resin is used as the thermosetting resin, the heating temperature is in a range of 80℃~150℃. When a phenol novolac resin is used as the thermosetting resin, the heating temperature is in a range of 80℃~230℃. In addition, an applied pressure is in a range of 0.1 kg/cm^2 to 3 kg/cm^2.

[0039]

The preliminary curing continues until a sufficient bonding strength reaches such that the position mismatch or bending of the overlapping substrate will not be generated due to the carrying and heat fluctuation. Preferably, the hot press process is performed for at least two minutes.

[0040]

Fig. 3 is a plan view schematically showing an arrangement of a hot press device for overlapping a pair of glass substrates shown in Fig. 1. A controller 20 controls an entire hot press device. A loader 21 includes two unit loaders 21a and 21b, each receiving the overlapping substrate, and sends the overlapping substrate to the hot press device 25 through the carry apparatus 23. Four hot presses 25a, 25b, 25c, and 15d are arranged in the hot press device 25.

[0041]

The hot presses 25a and 25b receives the overlapping substrate sent from the unit loader 21a. The hot presses 25c and 25d receives the overlapping substrate sent from the unit loader 21b.

[0042]

The overlapping substrate preliminarily cured by the hot press (heating and pressing) in the hot press device 25 is joined in the carrying apparatus 27, and carried in the cassette 31 through the carrying apparatus 29. The cassette 31 can receive a plurality of overlapping substrates. After a predetermined number of overlapping substrates are received, the cassette 31 is carried in the curing furnace 35 through the carrying apparatus 33.

[0043]

In the curing furnace 35, the thermosetting resin of each overlapping substrate undergoes a primary curing process. Through the primary curing process, the thermosetting resin is fully cured. For example, a heating process in the curing furnace 35 is performed for more than about 1 hour in a temperature of the above-mentioned heating temperature range. It is desirable that a curing ratio of almost 100% is accomplished. The overlapping substrate that finishes the primary curing process is carried to an unloader 39 through the carrying apparatus 37. In the unloader 39, the overlapping substrate is pulled out from

the cassette one by one, and sent to the subsequent processing through the carrying apparatus 41.

[0044]

In the hot press device 25, two hot presses 25a and 25b perform a series of hot press processes, while other two hot presses 25c and 25d perform another series of hot press processes. In the hot press device 25, a plurality series of hot press processes are performed in a sheet type.

[0045]

Figs. 4A to 4G is a schematic cross sectional view for explaining a series of sheet-type hot press processes.

[0046]

As shown in Fig. 4A, the hot presses 25a and 25b are adjacently arranged, and combined by the carrying apparatus 24 including rollers. In addition, the carrying apparatus including rollers may be a known apparatus, and may include other elements such as a pusher. The carrying apparatus 23 including rollers is arranged on the upper side of the hot press 25a, and carrying apparatus 27 including rollers is arranged on the lower side of the hot press 25b. Fig. 4A shows a state where two upper heating plates are all lifted. In this state, first, the overlapping substrate 51a is carried in to the hot press 25b at the lower side.

[0047]

As shown in Fig. 4B, the next overlapping substrate 51b

is carried in the upper side hot press 25a. In addition, during a process of carrying in the overlapping substrate 51b into the hot press 25a, the lower side hot press 25b that finishes the carrying process of the overlapping substrate initiates a lowering process of the upper heating plate UHP. For the upper side hot press 25a as well, the lowering process of the upper heating plate UHP is initiated after the carrying in the overlapping substrate 51b is finished.

[0048]

As shown in Fig. 4C, first, for the lower side hot press 25b, the upper heating plate UHP presses down the overlapping substrate 51a, and initiates the pressing and heating process. In this state, for the upper side hot press 25a, the upper heating plate UHP does not yet reach the surface of the overlapping substrate 51b.

[0049]

Fig. 4D shows a state where the upper heating plate UHP contacts with the upper surface of the overlapping substrate 51b, and initiates the pressing and heating process, for the upper side hot press 25a as well. The pressing and heating state (hot press) remains for a predetermined time.

[0050]

Fig. 4E shows a state where a predetermined processing time elapses and the upper heating plate UHP starts lifting,

for the lower side hot press 25b. For example, after the upper heating plate UHP reaches the overlapping substrate 51, and starts pressing and heating, the upper heating plate UHP starts lifting when more than two minutes (e.g., 3 minutes) of the hot press time elapses.

[0051]

Fig. 4F shows a state where the established processing time is expired, and the upper heating plate UHP starts lifting, for the upper side hot press 25a as well. In addition, for the lower side hot press 25b, the upper heating plate UHP is sufficiently lifted, so that the carrying apparatus 27 including rollers carries out the overlapping substrate 51a.

[0052]

Fig. 4G shows a state where the overlapping substrate 51b is carried out from the upper side hot press 25a, following the carrying out of the overlapping substrate 51a. In addition, two overlapping substrates 51c and 51d to be processed next are carried on a carrying route 23.

[0053]

Next, the overlapping substrate 51 is carried to the lower side hot press 25b, and goes back to the state of Fig. 4A. In addition, for the device of Fig. 3, the hot presses 25c and 25d perform the same tasks as for the hot presses 25a and 25b. Therefore, a throughput for the entire hot

press 25 will be twice larger than shown in Fig. 4.

[0054]

In the hot press process performed in a plurality of hot presses, while the above-mentioned start and end timings are deviated, an essential portion shown in Fig. 4D is performed side by side. The hot press process performed in the plurality of hot presses is a hot press having the same pressure and temperature.

[0055]

In the preliminary experiment shown in Fig. 7, two hot presses were used, and two-stage pushing hot press process was performed. For the two stage processing, after a former part of the upper hot press is processed, it is necessary to carry the overlapping substrate to the lower side hot press. In this carrying process, the overlapping substrate might receive a thermal stress and a mechanical stress generated by position mismatch or bending.

[0056]

With the hot press process of Fig. 4, two overlapping substrate are carried into the hot press one after another, and the hot press process is performed through two hot presses side by side, and after the hot press process is finished, the two overlapping substrate are carried out one after another. With respect to the throughput, two hot presses are used and the hot press process is performed in a

predetermined time period, so that the throughput hardly varies due to the hot press process of Figs. 4 and 7.

[0057]

With the hot press process of Fig. 4, one overlapping substrate remain in the pressed and heated state between a pair of heating plates until the preliminary curing process is finished. Therefore, the position mismatch or bending between the overlapping substrate will not be generated.

[0058]

In addition, it has been described that a plurality of hot presses can be connected in serial, and the serial connection is connected in plural parallels. The number of hot press connected in series and the number of hot press series connected in parallel can increase or decrease according to a condition. A plurality type of overlapping substrates may be divided into series for processing. In this case, the hot press condition may vary according to a series. The number of the hot press connected in serial may vary according to a series.

[0059]

In the device of Fig. 3, the controller 20 can control a heating temperature to gradually increase, conforming to a progress situation of the hot press process of each hot press. In addition, task timings of the loaders 21a and 21b and the lower hot press can be controlled.

[0060]

While it has been described in the context that the hot press is arranged in serial and parallel, the same process can be performed using different arrangement.

[0061]

Figs. 5A to 5C shows an arrangement other than serial and parallel one. In Fig. 5A, a carrying route 61 is arranged between a loader 60 and an unloader 68. Six hot presses 66a to 66f are arranged adjacent to the carrying route 61. A thermal chamber 67 surrounds 6 hot presses, and maintains the inner space to be a predetermined temperature, to thus reduce effect of a temperature of the external air. The same thermal chamber can be arranged in the hot press device 25 shown in Fig. 3.

[0062]

In the carrying route 61, there are provided a carrying path 62 that faces the unloader 68 from the loader 60 and a branching path 63 that branches from the carrying path 62 and connects to each hot press.

[0063]

A carrying robot 64 is included in the carrying route 61. The carrying robot 64 can move along the carrying paths 62 and 63, and can receive the overlapping substrate using rotation of a rotational axis and expansion and contraction of arms. In other words, the robot 64 can receive the

overlapping substrate from the loader to transfer any one of hot presses, and receive the overlapping substrate whose processing is finished from any one of the hot presses to transfer to the unloader 68.

[0064]

For six hot presses 66a to 66f, the same hot press process is performed in parallel.

[0065]

In addition, a two-armed robot is used as the carrying robot 64, one overlapping substrate is carried out from the loader 60, the overlapping substrate whose processing is finished is received among any one of hot presses 66, a new non-processed overlapping substrate is carried in, and the overlapping substrate whose processing is finished can be carried out to the unloader 68.

[0066]

Fig. 5a shows a plurality of hot presses arranged on one side of the carrying route 61.

[0067]

Fig. 5B shows an arrangement in which a plurality of hot presses are arranged at both side of the carrying route 61. On the left side of the carrying route 61, three hot presses 66a, 66b, and 66c are arranged adjacent to each other, and a thermal chamber 67a are formed around them. On the right side of the carrying route 61, in the same manner,

three hot presses 66d, 66e, and 66f are arranged adjacent to each other, and a thermal chamber 67b is formed around them. A robot 64 may accept the overlapping substrate from the loader 60, receive one desired overlapping substrate among six hot presses, accept the overlapping substrate whose processing is finished from the processing finished hot press, and carry out the overlapping substrate to the unloader 68. In addition, using the two-armed carrying robot, carrying in and out of the overlapping substrate can be successively performed, in the same manner as Fig. 5A.

[0068]

Fig. 5C shows an arrangement in which six hot presses 66a to 66f are arranged around a polygonal carrying chamber 61. The loader 60 and the unloader 68 are arranged at opposite positions of the carrying chamber 61. Positions of the loader and unloader are not limited to opposite ones. Each hot press 66a to 66f is surrounded with the thermal chambers 67a to 67f. In this case, it is not necessary for the robot to run in parallel, but it may be enough to expand and contract arms while rotating around a rotational axis.

[0069]

In addition, various types of carrying apparatus can be employed. Figs. 6A to 6C show examples of the carrying apparatus. In the same manner as shown in Fig. 5, the carrying robot constitutes a carrying apparatus in Fig. 6A.

For example, the carrying robot 64 carries the overlapping substrate between the loader 60 and the hot press 66.

[0070]

In Fig. 6B, a carrying apparatus includes a belt. The belt 65 on the carrying path 62 can reciprocate and rotate, and drive the belt to receive the overlapping substrate. When the overlapping substrate is received from the loader 60, the carrying apparatus operates as shown herein. When the overlapping substrate is received with the hot press along the carrying path 63, the carrying apparatus rotates in 90 degrees, and conforms a moving direction of the belt to the carrying path 63. After the belt 65 proceeds to the hot press 66, the belt 65 is driven to transfer the overlapping substrate on the lower heating plate of the hot press 66.

[0071]

Fig. 6C shows a case where the roller 69 combined with the belt 65 are used. The carrying apparatus 69 including rollers is arranged on the carrying path 62, and the carrying apparatus formed with the belt 65 is arranged in the hot press 66. The roller 69 is formed such that it can reciprocate and rotate. In the same manner as shown in Fig. 6B, the overlapping substrate is accepted, the roller 69 is rotated in 90 degrees, the carrying direction is matched to the carrying direction of the belt 65, and then, the

overlapping substrate is carried in.

[0072]

Besides, it will be apparent to those skilled in the art that various types of carrying apparatus can be employed. In addition, while it has been described in the context of forming a seal on the upper plate, scattering spacers on the lower substrate, and then, overlapping the upper substrate on the lower substrate, a method of forming an overlapping substrate is not limited hereto.

[0073]

Fig. 8 shows another overlapping forming method. As shown in Fig. 8A, the seal 11 is formed on the substrate S1 using a dispenser 14. In addition, the seal 11 can be formed with two stripe-type sealing materials and spacers therebetween, as described in the above-mentioned embodiment. In addition, according to the present embodiment, the seal 11 can be fully formed in a loop shape.

[0074]

As shown in Fig. 8B, the loop shaped seal 11 is formed, and an enclosed region therein is defined, and then, the liquid crystal 16 is dropped from the dispenser 15, and spread over a region with the seal 11. After forming a liquid crystal layer in a desired thickness, spacers are scattered into the liquid crystal layer.

[0075]

As shown in Fig. 8C, after forming the liquid crystal layer 16 scattered with the spacers 12, another substrate S1 overlaps over the substrate S1.

[0076]

Fig. 8D shows the substrates S1 and S2 overlapping through the seal 11 and the spacers 12. In addition, for the overlapping process, with an ambient in a vacuum state, air can be excluded from a space in the seal 11.

[0077]

In Fig. 8e, a manufactured overlapping substrate is interposed between the lower heating plate LHP and the upper heating plate UHP of the hot press through a buffer BF, and heating and pressing processing is performed thereon. In addition, it can also be arranged such that the upper heating plate and the lower heating plate of the hot press device are configured to be rotate, the upper heating plate and the lower heating plate are tightly pressed, rotated in 90 degrees, and lifted in a vertical direction, and then, the heating and pressing processing is performed thereon.

[0078]

While preferred embodiments of the present invention have been described, the present invention is not limited hereto. For example, it will be apparent to those skilled to the art that a variety of modifications, changes, and combinations can be made.

[0079]

[Effect]

As described above, according to the present invention, a process of bonding an overlapping substrate can be efficiently performed using a sheet type hot press. Since the preliminary curing can be performed in one successive hot press process, mismatch between the overlapping substrates or bending of the overlapping substrate can be easily prevented.

[Brief Description of the Drawings]

[Fig. 1]

Fig. 1 is a schematic perspective view and cross sectional view for explaining a bonding process of an overlapping substrate according to an embodiment of the present invention.

[Fig. 2]

Fig. 2 is a plan view showing a type of seal formed on the substrate, and a cross sectional view showing a state where a pair of substrates overlap through spacers.

[Fig. 3]

Fig. 3 is a schematic plan view of a device for performing an overlapping substrate bonding process of a liquid crystal display panel according to an embodiment of the present invention.

[Fig. 4]

Fig. 4 is a cross sectional view for explaining an operation of a hot press in the device of Fig. 3.

[Fig. 5]

Fig. 5 is a schematic plan view showing an arrangement of a hot press device according to another embodiment of the present invention.

[Fig. 6]

Fig. 6 is a schematic plan view showing an example of a carrying device.

[Fig. 7]

Fig. 7 is a cross sectional view and graph for explaining a preliminary experiment of the present inventors.

[Fig. 8]

Fig. 8 is a schematic perspective view and cross sectional view for explaining a process of forming an overlapping substrate according to another embodiment of the present invention.

[Reference Numerals]

US: upper substrate

LS: lower substrate

UHP: upper heating plate

LHP: lower heating plate

BF: buffer

11: seal

12: spacer

13: injecting port

14, 15: dispenser

16: liquid crystal controller

21: loader

23: carrying apparatus

25: hot press device

25a to 25d: hot press

27, 29: carrying apparatus

31: cassette

33: carrying apparatus

35: curing furnace

37: carrying apparatus

39: unloader

41: carrying apparatus

51: overlapping substrate

60: loader

61: carrying route

62, 53: carrying path

64: carrying robot

65: belt

66: hot press

67: thermal chamber

68: unloader

69: roller